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AUTHOR	Jiman, Juhanita
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ABSTRACT

This paper discusses the use of Virtual Reality (VR) in e-learning environments where an intelligent three-dimensional (3D) virtual person plays the role of an instructor. With the existence of this virtual instructor, it is hoped that the teaching and learning in the e-environment will be more effective and productive. This virtual 3D animated character can actually be programmed to have a natural human touch to help bridge the gap between a machine and a student. A virtual instructor that has an almost true-to-life look and feel of a human being will make the students feel more comfortable and confident to learn. (Contains 15 references.) (Author/AEF)

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Virtual Reality: The Future Of Animated Virtual Instructor, The Technology and Its Emergence To A Productive E-Learning Environment

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Juhanita Jiman
Center for Interpretation and Expression,
Faculty of Creative Multimedia, Multimedia University
Cyberjaya, MALAYSIA
juhanita@mmu.edu.my

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Abstract: The promise of Virtual Reality (VR) has caught our imagination and reliable networks will make it all a reality. VR will draw from and affect the entire spectrum of culture, science, and commerce, entertainment, and education industry. It will be multi-national, and will introduce new hybrids of experience for which descriptors presently merely exist.

In this paper, my major discussion will be the use of VR in e-learning environment where an intelligent 3D virtual person will play a role of an instructor. With the existence of this virtual instructor, it is hoped that the teaching and learning in the e-environment will be more effective and productive. This virtual 3D animated character can actually be programmed to have a natural human touch to help breaching the gap between a machine and student. A virtual instructor that has an almost true look and feel of a human being will make the students feel more comfortable and confident to learn.

Keywords: E-learning, Virtual Instructor, Intelligent Agent, Character Animation, Virtual Reality, Avatar, Collaborative Learning, Artificial Intelligence, Facial Expression.

Introduction

There are as many definitions as there are applications of "virtual reality". For most people, this technology is more seen like something magical, with endless possibilities. The best definition would be: "Virtual Reality is a way for humans to visualise, manipulate and interact with computers and extremely complex data. It is supported by advances in simulation technology that allow linking human capabilities and computational resources, sensor systems and robotics devices for real-time tasks." This was taken from the book "Silicon Mirage: The Art and Science of Virtual Reality". [1]

We foresee that computing environments in the near future will be very widely distributed and mutually connected. New services will be added from time to time, while old services will be replaced. Network topology and capacity will be changing almost continually. Users will demand much better user interfaces, so that they will be able to communicate with computers as if they are communicating with humans. VR technology can be applied to many tasks that would be more difficult to do by other methods. With VR technology, a human and a computer operate together as a combined system, one that is far more capable than either taken individually when performing a large variety of tasks. It offers a multitude of ways to improve productivity. VR will not serve only to create hit video games or other applications of that sort, but, more importantly, this technology is put towards more functional applications.

In education, VR would allow collaborative and distance learning to occur more successfully and make students to travel to places that may not be feasible otherwise. They could do scientific experiments in a simulation even though they could not afford to do the real experiment because of the cost of the equipment. Furthermore, in the educational domain, VR without any doubts has played an important role to assist teaching. There has long been a philosophical gap between distance education and efficient training skills, and because of these difficult tasks, VR has increasingly become an important teaching aid. With the emergence of this technology, education and training are now getting their feasible and better solution. Education's goal which has traditionally been to impart high-level cognitive skills that would tie a lifelong learning process

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and training's goal which was to bring performance up to a skill level that would let people successfully carry out new tasks can now be improved with the help of VR solutions.

Content

LEARNING WITHOUT LIMIT

Collaborative Learning and Virtual Reality Learning Environment

Collaborative Learning in VR provides an environment to enlighten and enrich students' learning process. This will be a better place where they could benefit it the most without having to go to a real classroom or a training place. Introducing interactive virtual instructor or partners into an educational system creates more realistic social contexts, thereby it will increase the effectiveness of the learning system. This almost 'true human' virtual learning environment would definitely help sustain the student's interests and would provide a more natural learning habitat.

As Piaget [2][3], pointed out, collaborative learning has a major role in constructive cognitive development. His theory is consistent with the other popular learning theory [4] in emphasising the importance of collaboration. Piaget felt that interaction between peers has to be equally shared in a collaborative environment to maintain performance.

In one-to-one computer-based tutoring, the system interacts with one student and attempts to personalise the tutoring to the needs of the student. On the other hand, in a one-to-many collaborative learning environment, the system interacts with a group of students, imparting the subject knowledge using a collaborative learning strategy. It should be distinguished that a one-to-N environment is not a combination of many one-to-one learning environments. Collaborative learning presents an environment in which a student interacts with one or more collaborating peers to solve a given problem. The interactions among the students are monitored and controlled by a collaborative learning system and in this case this monitoring or mentoring system will likely doing its best if it is supervised by an animated character as a virtual instructor.

In general, collaborative learning is found effective in domains where peers are engaged in skill acquisition, joint planning, categorisation, and memory tasks. The idea is that peers learn the prerequisites of the topic to be learned and reinforce the topic using the collaborative environment. There have been a number of studies that proposed collaborative learning to help learners understand complex tasks. For example, Miyake[5] shows that the complex understandings of the working of a tailoring machine is better understood when the peers interacted collaboratively and attempted to understand the problem. Connah et al. [6] believe that the co-operative behaviour supports higher cognitive learning, based on a simulated physical world domain.

LEARNING WITH ASSISTANCE

The Needs for Virtual Instructor

In a traditional classroom, out-spoken and active students can easily dominate class discussion. Even a skilful educator should learn how to cut this off without alienating the over-talker, but time is still lost in the process. In the asynchronous online course, with the existence of a virtual facilitator, each participant is given equal time for participation. Verbose response can be skimmed or ignored. In addition, students can benefit equal information sharing and the learning environment will somehow becomes more productive.

It is obvious that in any e-learning environment, the instant availability of a human tutor would be the most ideal way to help out if there's any complications occur involving the course materials, however, providing this capability is no more realistic than continuously providing a human tutor for the traditional classroom-based learning experience. Cost and availability are limiting factors in supplying continuously attentive human tutors. Often students simply want questions answered and would be happy with any type of effective immediate feedback, it does not matter whether it comes from a human or machine. It is still under intensive research to 'create' an avatar as an intelligent agent who is capable to give any type of on-demand feedback for certain types of information requirements.

In most cases of e-learning delivery systems, a virtual instructor is foreseen to play an important role to enhance the overall e-learning activity. It is hoped that in the nearest future, an 'almost human' virtual instructor would help the advancement of e-learning technology. An intelligent agent here, is a 'programmed' character which is considered by e-learning user as an assistant or facilitator. This agent does not function as a tool that is normally use in a conventional direct-manipulation interface, but, it serves the user with a more personal assistance. This agent should be able to illustrate

characteristics that are associated with human intelligence: learning, judgement, adaptability, independence, creativity, emotion, etc.

While students are in the e-learning environments, there are risks of losing cohesiveness and spontaneity of the classroom experience, therefore, it is essential to understand how to improve the e-learning experience, and hopefully this virtual 'facilitator' will even exceed traditional teaching and learning methods.

Virtual Reality Learning Environment

Virtual reality simulation environments can also be part of elearning delivery method which offers exciting opportunities and challenges for intelligent tutoring systems. Students, immersed in a 3D computer simulation of their work environment, improve their skills through practice on realistic tasks. Computer tutors can inhabit the virtual world along with students, allowing them to physically collaborate with students on tasks, and they can interact and communicate in non-verbal or verbal communication.

The research reported for ALN courses stated that electronic or computer based learning can be improved by the introduction of autonomous intelligent software agents. This finding has been shown in several ALN (Asynchronous Learning Networks) venues [7], [8]. Intelligent Agents (IAs), can perform the duties of online facilitators for routine tasks. Checking computer code, responding to simple questions, reminding learners about the need to turn in assignments and potentially even grading essays [9] are among the types of things that intelligent agents can accomplish.

With this advent of intelligent agents, it enables learners to be trained, manipulate and work within the 3D virtual world, which finally led to the interactive learning systems of the new millennium.

Animated Virtual Instructor that Has Intelligence

In the midst of needing a mentor in e-learning environment, it comes to attention that a virtual instructor would be the answer to all the woes. This virtual instructor would be in a form of animated human being. This animated agent will play a role of a *'Virtual Instructor'*.

This *'Virtual Instructor'* as an intelligent agent is programmed to have a natural human touch to help breaching the gap between a lifeless machine and the student. As a character that has an almost true look and feel of a human being, this agent will make the students feel more comfortable and confident to learn. While students are interacting to this agent, they will experience a sense of equality. Nervous or slow students will feel more comfortable in any of the learning activities and feel more secure when communicating with this virtual person instead of speaking in an actual training place. As a whole, this agent is programmed to be more accessible, patient, understanding and most of all efficient in all aspects.

Getting the right information is crucial for the emotional process and for this agent to generate an accurate or desirable answer. Therefore, this agent is designed to have abilities to 'learn' and later to track the history of events that have happened, then, link it to the most likely solution.

Desirable Qualities of 3D Character as an Intelligent (Software) Agent

Etzioni and Weld defined the term "software agent" as a computer program that behaves in a manner analogous to a human agent [10]. In essence, the term refers to software that supports a social interface metaphor, a dialogue between a person and the agent. Various researchers proposed the following characteristics as desirable qualities of software agents :

- Autonomy: An agent initiates and exercises control over its own actions in the following ways:
  - Goal-oriented: accepts high-level requests indicating what a human wants and responsible to decide how and when to satisfy the requests.
  - Collaborative: does not blindly obey commands but can modify requests, ask clarification questions, or even refuse to satisfy certain requests.
  - Flexible: actions are not scripted; the agent is able to dynamically choose which actions to invoke, and in what sequence to do the action.
  - Response to the state of its external environment.
  - Self-starting: unlike standard programs directly invoked by the user, an agent can sense changes in its environment and decide when to act.
- Temporal continuity: An agent is a continuously running process, not a one-shot computation that maps a single input to a single output and then terminates.
- Personality: An agent has a well-defined believable personality that facilitates interaction with human users.

- Communication ability: An agent can engage in complex communication with other agents, including people, to obtain information or enlist help to accomplish its goals.
- Adaptability: An agent automatically customises itself to the preferences of its user on the basis of previous experience. It also automatically adapts to changes in its environment.
- Mobility: An agent can transport itself from one machine to another and across different system architectures and platforms.

Virtual Instructor in VR Learning/Training Environment (Farieda)

- ***Farieda in General***

As it was said earlier, virtual reality can be used for any training needs, from linguistics, mathematics, sciences, computer skills, engineering and many others. To master complex tasks in different kinds of training, students definitely need hands-on experience and they have to face a wide range of situations. They also need a mentor/instructor that can demonstrate procedures, answer questions, and monitor their performance, while on the other hand, they may also need other students' participation (team-mates) if their task requires multiple people.[11] It was hypothesised that face-to-face professor-student interaction is crucial to test performance. However, the data indicate the reverse, that virtual interaction produces better results. [12]

Medicine will probably be the most commonly known area that VR is used for training, but, apparently, it is not the only area that can utilise VR in its applications. There are also many branches of other scientific and non-scientific fields to adopt virtual reality for diverse applications. In other words, it means that this enabling technology can be used to improve productivity in many important areas. There are numerous applications in the domains of health care, education and lifelong learning, manufacturing and other areas where this technology shows great promise.

In the midst of needing a mentor in collaborative VR learning environment, it comes to attention that a virtual instructor would be the answer to all these problems. This virtual instructor would be in a form of an animated human being and it will play a role of an 'intelligent instructor'. The agent is given a name as Farieda (**F**riendly **A**nd **R**eliable, **I**ntelligent **E**-Learning **D**evelopment **A**gent). Farieda integrates methods from four primary research areas: intelligent tutoring systems, computer graphics, agent architectures and speech recognition. This novel combination results in a unique set of capabilities.

Farieda is programmed to have a natural human touch to make the communication between a machine and student to occur more successfully. As a virtual instructor that has an almost true look and feel of a human being, she will make the students feel more comfortable and confident to learn. While students are interacting to Farieda, they will as if that they are interacting with a natural human tutor. In addition, nervous or slow students will feel more comfortable in this training because they will feel more secure when communicating with this virtual person instead of speaking in an actual training place. As a whole, Farieda is programmed to be more accessible, patient, understanding and efficient in all tasks given to her as a 'tutor or facilitator'.

- ***Farieda Architecture and Capabilities***

Farieda's artificial intelligence is designed to allow more human-like interactions among synthetic agents and humans. Her speech recognition makes her appeared to be more human than other virtual instructor. Farieda's architectural capabilities on the other hand, allows her to energetically handle a dynamic virtual world, where this becomes a place where people and other agents meet. She will continually monitor the state of the virtual world, always maintaining a plan for completing her current task, and revising the plan to handle any unexpected situations.

Getting the right information is crucial for the emotional process and for this agent to generate an accurate or desirable answer. Therefore, Farieda is designed to have abilities to 'learn' and later to track the history of events that have happened, then, link it to the most likely solution. She has many instructional capabilities one would expect of an intelligent tutoring system. For example, she can answer questions such as: ***"What should I do next?"*** and ***"Why?"***. On the other extreme, by using her voice recognition capabilities, she can also give responses if she's sensing that the student is not paying attention or confused, she will say ***"Are you ok there? Why are you keeping quiet?"*** or if she's sensing that the students are having fun, she will say ***"That's enough let's go back to our topic!"***. Moreover, because she has an animated body, and cohabits the virtual world with students, she can provide more human-like assistance than the disembodied tutors. For example, she can demonstrate actions, use gaze and gestures to direct the student's attention, and guide the student around the virtual world.

More importantly, Farieda is designed and programmed to have a set of domain-independent capabilities that utilise a declarative representation of domain knowledge. To teach students about the tasks in a new domain, Farieda will be

programmed with the appropriate domain knowledge in detail and she has to 'know by hard' whatever topic or content that is relevant to what she is going to teach. It is assumed that Farieda will be a course author, a person with enough domain knowledge to create a course for teaching others. Importantly, people should not aware that Farieda has any programming skills or being programmed, ensuring that Farieda only relies on types of knowledge that a course author can provide imposes strong constraints on Farieda's design. Farieda is designed to coexist with other people and agents in a virtual world. Her goal is to support team training and collaborative learning, where teams of people, possibly at different locations, can inhabit the same virtual world and learn to perform tasks as a team.

- ***Farieda's Gesture, Look and Feel***

As a virtual instructor who has to have a look and feel like a natural human beings, Farieda is modelled with a detail human character and her gesture is more or less have to reflect on what natural human is capable of doing. Farieda will not only show a set of different facial expressions to show her so-called 'emotion', her body movement or gesture will also be an important part in her existence.

As an intelligent agent, Farieda is supposed to be sensitive towards her virtual collaborative learning environment. For example, if Farieda is sensing that one of her students or trainees is not paying attention, she will show that she cares by giving a positive comments and ask the student to pay more attention, but if repeatedly the same student is doing the same thing and this is distracting other students who are engaged in that collaborative learning, she will be more firm and has the authority to log out the destructive student.

- *Farieda's Facial Expression*

Farieda's artificial intelligence is designed to allow more human-like interactions among synthetic agents and humans. One of the particular strengths of animated characters is their ability to express emotions in a believable way by combining facial expressions with body gestures and affective speech. [13]

Farieda's personality is represented by a vector of discrete values along a number of psychological traits, such as extraversion, openness or agreeableness, that uniquely characterise an individual. These personality traits are not influenced by current events, but remain stable over a longer period of time. [14] Thus, this agent becomes more personal and individual, where it would be almost 'human' who has feeling and emotion. Within these agents' believable human 'personality', they can give comments within their domain knowledge, show dedication through their friendly approach, show their sensitivity through voice intonation (if not happy the intonation would be higher and vice versa), able to make simple laugh and show appreciation but most of all they are better than human because they will never be tired, bored or incline to favouritism and discrimination.

It has come into researchers' attention that ability to express emotions is important for creating believable interactive characters. To simulate emotional expressions in an interactive environment, an intelligent agent needs both an adaptive model for generating believable responses, and a visualisation model for mapping emotions into facial expressions. [15]

Figure 1,2 & 3 : Farieda's normal expression, laughing and curious.

Figure 4,5 & 6 : Farieda's saying 'o', she's talking and feeling uncomfortable.

Figure 7 & 8 : Farieda's angry and thinking.

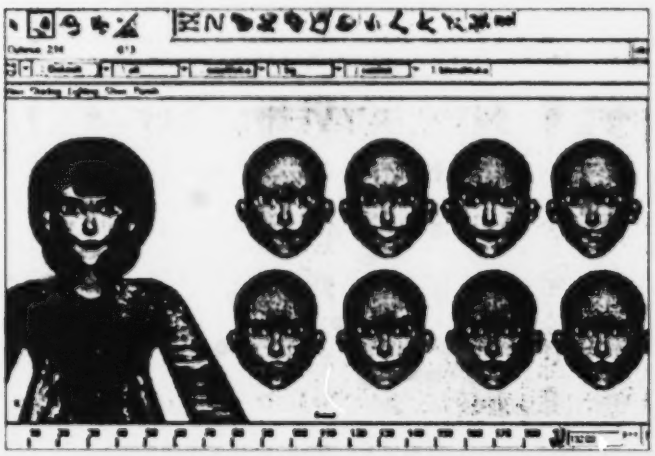

Figure 9 : Farieda's facial anatomy

Conclusion

VR enabling technology can be used to improve productivity in many important areas. There are numerous applications in the domains of health care, education and lifelong learning, manufacturing and other areas where this technology shows great promise. Early results have shown increased productivity and a dramatic reduction of resource requirements in many instances and from there the future of VR is seen more encouraging.

In many cases of VR applications, virtual training is one of the highly demanded solutions. Self-paced training is known to be responsive to every learner's needs and with the help of a virtual instructor in a form of animated 3D character, the learning process can be more interesting and effective.

Teaching and learning in a conducive environment definitely will help students/learners to benefit the most from the learning process. Optimal learning satisfaction has been proven to give a major impact on the emotional process, therefore, satisfied students will not only be motivated to learn but in a way they will be 'hooked ' and committed to their study. Guided lessons can be enriched by having "somebody" to who the learner can refer. This implies the provision of a

'virtual instructor'. A talk agent as a virtual instructor could replace streaming video instruction and act like a 'true' human instructor.

Even with the existence of this virtual instructor, it is still a student-centered teaching approach where the students themselves determine what their needs are. The virtual instructor's most crucial job is to accommodate different learning styles and provide them with opportunities for exploration. It is hoped that the ability of the virtual instructor to communicate with the learner will advance e-learning to a higher level.

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